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Status of the Western Blue Flag (Iris missouriensis) in Alberta

Joyce Gould

Alberta Wildlife Status Report No. 21

Alberta Conservation Association

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PREFACE

Every five years, the Fisheries and Wildlife Management Division of Alberta Natural Resources Service reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991 and 1996, assign individual species to 'colour' lists that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A primary objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the 1996 *Status of Alberta Wildlife* review process, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province (Red or Blue listed), that are of uncertain status (Status Undetermined), or which are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fisheries and Wildlife Management Division of Alberta Environmental Protection, and are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information which will assist the Alberta Endangered Species Conservation Committee to identify species that may be formally designated as endangered or threatened under the Alberta Wildlife Act. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

Western blue flag (Iris missouriensis Nuttall), is distributed primarily in the western United States but just penetrates Canada along the southeastern flanks of the Rocky Mountains in Alberta. It is considered rare in Canada and Alberta. Western blue flag is currently designated as 'threatened' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1998). This report is intended to summarize the existing information on western blue flag in Alberta to assist with assessment of its status.

Western blue flag is a species of wet meadows and shorelines. In Alberta it occurs in these habitats only in the extreme southwestern corner of the province. It is restricted to the Foothills Fescue Grassland and Foothills Parkland Natural Subregions - areas that have undergone extensive modification from their natural state by human activity. Currently, western blue flag is known from six native occurrences. The population at one additional native site has been extirpated since its discovery in 1964.

The current population of western blue flag in Alberta is estimated at less than 7500 stems. The number of individuals is unknown but is certainly less than this. Monitoring activities indicate a decline in the number of non-flowering and flowering stems. The most significant causes of the decline is attributed to heavy grazing pressure, habitat alteration including flooding, and outcompetition by non-native species.

Western blue flag was probably never abundant in Alberta given its specific habitat requirements and current distribution. However, it is a significant part of our native flora and efforts should be made to halt the apparent decline in populations here.

ACKNOWLEDGEMENTS

The assistance of several people in the writing of this report is gratefully acknowledged: Peter Achuff (Jasper National Park) for information on western blue flag populations in Montana, Darcy Brown (Ranger-in-charge, Police Outpost Provincial Park) for information on the status and management activities related to western blue flag within the Park, Patsy Cotterill (Alberta Natural Heritage Information Centre (ANHIC), Alberta Natural Resources Service) for data compilation and processing of element occurrence information, June Dobberpuhl (Wisconsin Natural Heritage Program) for status information for Wisconsin, George Douglas (British Columbia Conservation Data Centre) for information on populations in British Columbia, Dave Dyer (herbarium, University of Montana) for distributional and specimen information for Montana, Ben Franklin (Utah Natural Heritage Program) for information for Utah, Barry Greig (Devonian Botanic Garden, University of Alberta) for information on cultivation of the species in Alberta, Duke Hunter (ANHIC) and Jane Horb (Ducks Unlimited Canada) for producing the maps, Jane Lancaster (Kestrel Consultants, Calgary) for information on seed sources in Alberta, Darla Lenz (North Dakota Natural Heritage Inventory) for information on status in North Dakota, Dave Ode (South Dakota Natural Heritage Data Base) for information on status and distribution in South Dakota, Sabra Schwartz (Arizona Heritage Data Management System) for information on status in Arizona, Cathy Seibert (herbarium, Montana State University, Bozeman, Montana) for distributional and specimen information for Montana, Welby Smith (Minnesota Natural Heritage and Nongame Research) for status information for Minnesota, Dragomir Vujnovic (ANHIC) for data compilation and processing of element occurrence information and Cliff Wallis (Cottonwood Consultants, Calgary) for fruitful discussions on distribution and population status in Alberta. Patsy Cotterill reviewed and edited the first draft of the report. The assistance of three reviewers, Beth Cornish, Derek Johnson and Cliff Wallis is greatly appreciated.

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INTRODUCTION

Western blue flag (Iris missouriensis Nuttall) is the only species of Iris native to Alberta. It is widely distributed in the western United States but enters Canada only in Alberta where it is present along the southeastern flank of the Rocky Mountains. Western blue flag is restricted to the Foothills Grassland and Parkland Subregions - areas that have been extensively modified by agriculture with few native tracts remaining (Alberta Environmental Protection 1997a). There are few native occurrences in the province and the species is ranked S1* by the Alberta Natural Heritage Information Centre (Alberta Natural Heritage Information Centre 1999). Western blue flag is also designated as 'threatened' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1998).

The purpose of this report is to summarize current and historical information on western blue flag in Alberta as a step in assessing the status of the species in the province.

The use of common names in the text follows Alberta Environmental Protection (1993).

HABITAT

In Alberta, western blue flag is restricted to the Foothills Fescue Grassland and Foothills Parkland Natural Subregions (Alberta Natural Heritage Information Centre1998b). The majority of native occurrences (i.e., distinct locations where the species occurs) are in the Foothills Fescue Grassland and only one is in the Foothills Parkland. These Subregions are characterized by a climate with mean annual precipitation ranging from 650 mm in the south to 500 mm in the north, with mean precipitation for May to September of 290 mm and a frost-free period averaging 90 days (Achuff 1994). The mean temperature for May to September is 11 to 13°C for the Foothills Grassland and 12 to 13°C for the Foothills Parkland (Achuff 1994). The soils of the Foothills Fescue Grassland are dark brown and black chernozems. Black chernozems are dominant in the grassland portion of the Foothills Parkland (Achuff 1994).

Ideal climates for growing Iris have been described as having cold, dry winters with moist springs and early summers followed by warm, dry, mid- to late summers (Mathew 1989). Western blue flag is a plant of moist meadows such as those found along freshwater shorelines and streambanks. The species is often found in areas with soils that dry out later in the summer (Dykes 1913, Price 1966, Hitchcock et al. 1969, Mathew 1989, Cronquist 1994). It is intolerant of permanently wet conditions and heavy shading (Dykes 1913). Native populations of western blue flag in Alberta occur on sites that are on level terrain or gentle slopes with moisture conditions where water is removed slowly enough to keep the soil wet for most of (hygric) or a significant portion of (sub-hygric) the growing season (Wallis 1988, Cornish 1998). Many of the stands of western blue flag are in close proximity to willow thickets around depressions or drainages (Wallis and Bradley 1990).

Six plots within three of the native occurrences of western blue flag in southwestern Alberta have been monitored periodically since 1987 (Wallis 1988, Cornish 1998). Four of the six plots are situated at the site known as Hendry, near Carway (Appendix 2). These plots occur on level terrain with abundant subsurface moisture from adjacent wetlands. The plot at Police Outpost Provincial Park is also on level terrain and is in close proximity to the shore of

* See Appendix 1 for definitions of selected status designations

Outpost Lake. The plot at Whiskey Gap is on a gentle (5%) south-southwest facing slope that receives some moisture from springs (Wallis 1988). Elevation for all of the known Alberta occurrences ranges from 914 to 1370 m (Alberta Natural Heritage Information Centre 1998b) although Mathew (1989) states that the species can occur up to 3000 m.

The principal vegetation composition of Alberta western blue flag sites appears to be transitional between the shrubby cinquefoil/ rough fescue (Potentilla fruticosa/Festuca scabrella) and the tufted hair grass (Deschampsia cespitosa) habitat types of northern Montana (Mueggler and Stewart 1980). Kentucky bluegrass (Poa pratensis) and inland bluegrass (P. interior) dominate at most of the Alberta sites. Forbs that comprise a significant component of the ground cover include Canada goldenrod (Solidago canadensis) and heart-leaved alexander (Zizia aptera). Other associated species include silverweed (Potentilla anserina), smooth aster (Aster laevis), prairie gentian (Gentiana affinis), wild chive (Allium schoenoprasum), northern reed grass (Calamagrostis inexpansa), mountain cinquefoil (Potentilla diversifolia), graceful sedge (Carex praegracilis), timothy (Phleum pratense), alpine hedysarum (Hedysarum alpinum), northern bedstraw (Galium boreale) and wild strawberry (Fragaria virginiana; see Wallis 1989).

The habitat of the population at Police Outpost Provincial Park is being severely altered by an invasion of smooth brome (Bromus inermis; Cornish 1998). Native grasses that were dominating the site in 1987 are currently being outcompeted by the smooth brome (Cornish 1998).

CONSERVATION BIOLOGY

There is very little data in the literature that is specific to the conservation biology of western blue flag. However, there is considerable information on the genus Iris, much of which is applicable to I. missouriensis.

Western blue flag is a member of the family Iridaceae (Mathew 1989). It is a perennial herb with thick (1 to 1.5 cm) rhizomes from which are produced tufts of leaves. The flowering stalks bear two to four showy flowers (Moss 1983) that range in colour from pale blue to deep blue or lavender (Mathew 1989). White-flowered forms also occur but are rare (Price 1966). The flowers bloom sequentially rather than all at once (Eastman 1995). Flowering dates for western blue flag throughout its range are May through July (Hitchcock et al. 1969, Mathew 1989). In Alberta, flowering occurs between mid-June and early July (Wallis and Bradley 1990, Cornish 1998).

Both sexual and asexual methods of reproduction occur in western blue flag. Asexual, or vegetative, reproduction is accomplished through the branching and linear growth of the rhizome. Typically, Iris is found in small patches of plants that are genetically identical (clones) and rarely forms large pure stands (Eastman 1995). The periods of most active growth are autumn and early spring (Mathew 1989).

The large, showy flowers of Iris are adapted for pollination by insects, primarily bees (Order Hymenoptera; Lyon 1973, Fægri and van der Pijl 1979, Schofield 1989, Eastman 1995) although flies (Order Diptera) have also been listed as pollinators (Fægri and van der Pijl 1979, Eastman 1995). Nectar 'guides' are present on the sepals (falls) (Mathew 1989, Schofield 1989, Eastman 1995) which curve downward, thereby forming a landing surface. The petals (standards) are erect. The anthers and the stigmatic surfaces are positioned between the petals and sepals of the flower such

that when an insect enters the flower in search of nectar, the insect deposits pollen from its body onto the stigma and picks up more pollen from the anthers. The style and stigma are positioned so that they face away from the anthers thereby reducing the chance of self-pollination (Eastman 1995).

The fruit of Iris is a three-parted capsule that splits to release its globose, smooth-skinned seeds (Dykes 1913). The seeds can be dispersed by wind (Wallis and Bradley 1990) and by water (Eastman 1995). Fruiting stems persist for one year or more (Mathew 1989). Wallis and Bradley (1990) reported that the Alberta populations of western blue flag have good seed set. Western blue flag grown at the Devonian Botanic Garden near Edmonton require a germination period of two to three months and flower production follows in two to three years (B. Greig, pers. comm.).

Eastman (1995) lists several insects that are known to reside in or forage on Iris flowers. Fægri and van der Pijl (1979) also note that ants (Order Hymenoptera) occupy the flowers of many Iris species and will feed on nectar and guard against beetles (Order Coleoptera) that lay eggs in the inflorescence. It is unknown which of these invertebrates, if any, use western blue flag in Alberta. Broad-tailed hummingbirds (Selasphorus platycercus) and various lepidopterans (butterflies and moths) have been documented while feeding on nectar in Iris missouriensis in the Chiricahua Mountains in Arizona (Lyon 1973). Eastman (1995) also lists various butterflies as nectar-feeders on members of the genus Iris. Again, the use of western blue flag by either hummingbirds or butterflies in Alberta is unknown.

The role of pollinators and outcrossing in seed production of Iris missouriensis is not known. A recent study on Iris versicolor, a similar species from eastern North America, showed that at least one population was self-compatible and there was no evidence of inbreeding depression (Zink and Wheelwright 1997). like I. missouriensis, this species is also insect-pollinated, exhibits clonal growth and occurs in isolated wet habitats (Zink and Wheelwright 1997). Self-pollination has been shown to occur in flowers that have not received pollen from other sources by downward curvature of the stigmas, which brings them into contact with the anthers (Zink and Wheelwright 1997). In plants growing in exposed habitats, wind was a factor in increasing the chance of self-pollination through air-borne movement of pollen by bringing neighbouring flowers into contact or by movement of the stigmas (Zink and Wheelwright 1997).

Investigation of the breeding system of a second eastern Iris, I. lacustris (Planisek 1983) showed that this plant is self-compatible, with self-pollinated flowers having more fruits than outcrossed ones. In addition, fruit set is not correlated with the density of growing shoots or flowers. Planisek (1983) also found that plants are at least seven years old before they flower. It was demonstrated that ants dispersed the seeds of this species. The seeds of I. lacustris, however, have an eliosome (oil body) which is a known indicator of ant dispersal. The seeds of I. missouriensis are smooth and lack eliosomes (Dykes 1913) and it is not known whether ants or other agents aid in the dispersal of seeds of western blue flag.

The rhizome of the western blue flag is able to withstand heavy trampling and spread quickly upon removal of other vegetation (Dayton 1960). It is reported that plants can become weedy in certain instances (Montana State University Herbarium 1998). Eckert et al. (1973) found that conditions of poor range management promoted the growth of western blue flag in Nevada. In Alberta, light or

moderate grazing appears to be beneficial to western blue flag by reducing competition from other vegetation (Wallis 1989, Wallis and Bradley 1990, Cornish 1998). Flower production of western blue flag appears to be highest in lightly grazed areas (Wallis 1989). Heavy grazing, however, has been shown to be detrimental to vegetative growth and flowering of the species both in Alberta (Wallis 1989, Wallis and Bradley 1990, Cornish 1998) and North Dakota (D. Lenz, pers. comm.).

DISTRIBUTION

1. Alberta. - Western blue flag was first discovered in Alberta in 1964 from two locations in the southwestern corner of the province (de Vries 1966). Since then, five additional native locations have been discovered together with five locations where the species has evidently been introduced (Figure 1). Native locations are restricted to the extreme southwestern edge of the province, the most floristically diverse portion of Alberta. This area has been described as a "botanical watershed" that runs east-west across the Rocky Mountains at approximately 50°N latitude (Kuijt 1982). The flora south of this 'divide' is more closely affiliated with that of the Rocky Mountains of northern Montana east of the Continental Divide rather than of the Rocky Mountains of Alberta to the north of it. Achuff (1997) points out the high diversity of the southwestern montane and foothills areas of the Rocky Mountains. For example, he documented 971 vascular plant species for Waterton Lakes National Park compared to 908 and 854 for Banff and Jasper National Parks, respectively (Achuff 1997).

In Alberta, western blue flag is restricted to a small zone extending from the western portion of the Milk River Ridge to just west of Carway (southwest of Cardston; Wallis 1989; see Figure 1). It has not been found on the Milk River Ridge itself despite the existence of suitable habitat there. The locations in Alberta represent the only known locations in Canada for this species. A check of herbarium collections in Montana indicates that the nearest known populations in Montana are approximately 6.5 km from the southernmost Alberta sites (C. Seibert and D. Dyer, pers. comm.). However, it should be noted that these represent collections only and other sites closer to the Alberta populations may exist from which collections have not been made.

2. Other Areas. - Western blue flag is a widespread species within western North America, primarily the United States. It occurs in Oregon, Idaho, Montana, North Dakota, South Dakota, California, Washington, Colorado, Nevada, Arizona, New Mexico, Wyoming, Utah, Nebraska, Mexico and Alberta (Figure 2). It has been reported in Minnesota (McGregor et al. 1977) although no documentation exists for this record and Iris missouriensis is not considered part of the native vascular flora of that state (W. Smith, pers. comm.) or adjacent Wisconsin (J. Dobberpuhl, pers. comm.). Isolated populations were reported for British Columbia but these plants have since been redetermined as another species, Iris setosa Pallas ex Link (G. Douglas, pers. comm.).

POPULATION SIZE AND TREND

1. Alberta. - Six natural (native) occurrences or locations of western blue flag are currently known to exist in Alberta (Alberta Natural Heritage Information Centre 1998b) representing a total population size of approximately 7500 stems (cluster of basal leaves; Wallis and Bradley 1990; Appendix 2). As several stems can arise from an individual rhizome or rhizome segment the number of individual plants is difficult to estimate but is undoubtedly lower than the total stem count

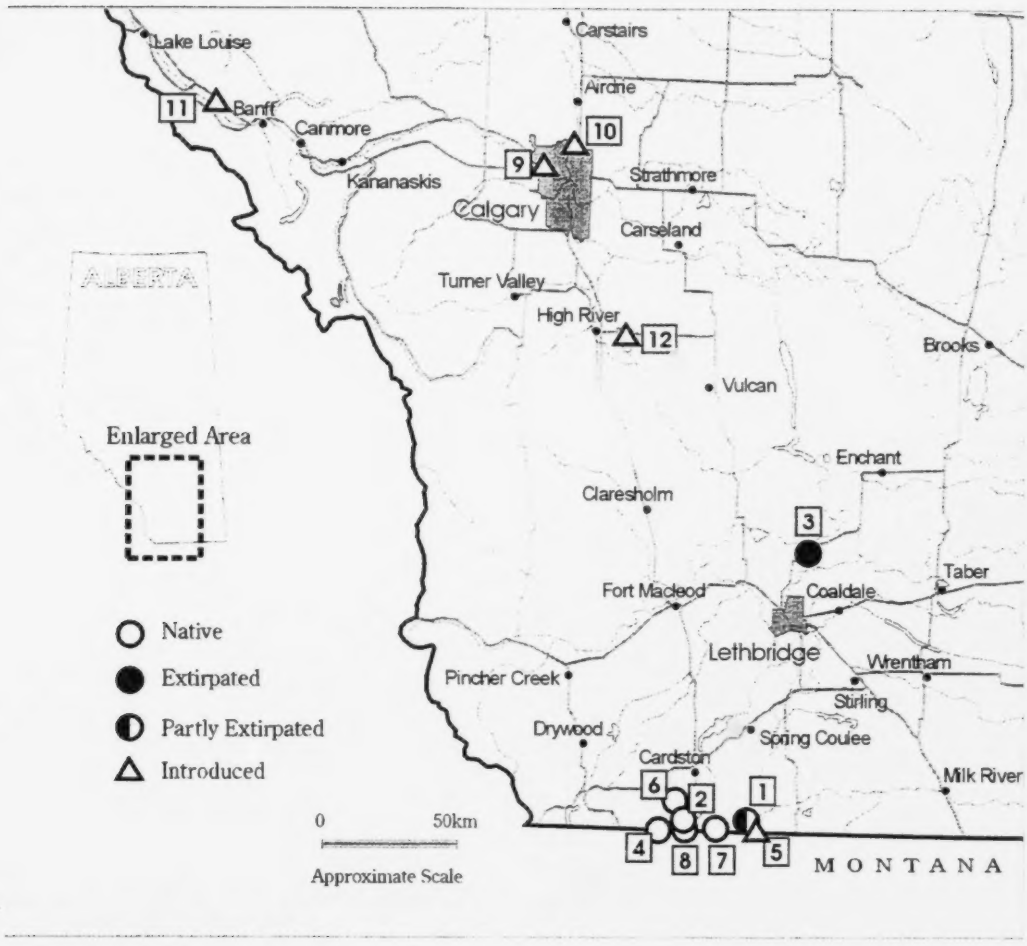

Figure 1. Known occurences of western blue flag in Alberta (Alberta Natural Heritage Information Centre 1998b). Numbers correspond to detailed descriptions of the occurences included in Appendix 2.

(Wallis and Bradley 1990).

The origin of one of the apparent native occurrences, at Picture Butte (Appendix 2), is uncertain as the habitat is not ideal (Wallis et al. 1986) and it is separated from the main native occurrences by a distance of approximately 80 km. This population has since been extirpated. The five remaining occurrences known in the province are all thought to have been introduced (Stiles 1995, C. Wallis, pers. comm.).

The number of historical occurrences of western blue flag is unknown. However, at least one known population and one known subpopulation have been extirpated since 1964, the time of first discovery in Alberta (Wallis et al. 1986, Wallis and Bradley 1990). Wallis (1989) reported that the Police Outpost population may have been more extensive in the past and cultivation has reduced the amount

Figure 2. North American distribution of western blue flag (modified from McGregor et al. 1977 and Wallis and Bradley 1990).

of available habitat in which western blue flag occurs (Wallis et al. 1986). Wallis (1989) also indicated that a dugout at the 'Beazer' occurrence (Appendix 2) might have had a negative impact on the population at that location. Populations of western blue flag may in fact have been considerably higher in appropriate habitat in the past. However, much of the Foothills Fescue Grassland and Parkland has been brought into cultivation or otherwise modified (see 'Limiting Factors' section, below).

Wallis (1989) reported that five of the eight sites that he examined had been modified or destroyed by human activities. Plants at the Whiskey Gap site (Appendix 2) were described as being in poor condition, possibly due to changes in drainage patterns resulting from heavy use by cattle (Wallis 1989).

Counts of individual flowerless and flowering stems were made in each of the six monitoring plots established by Wallis (1988) at the Hendry, Whiskey Gap and Police Outpost sites in 1987 (see 'Habitat' section, above). A follow-up to this study was done in 1998 (Cornish 1998) and the results are presented in Tables 1 and 2. Cornish (1998) noted that there were approximately 325 stems of Iris (including one flowering stem) outside of the monitoring plot at Police Outpost Provincial Park. This is similar to the number reported by Wallis in 1987. She also noted that there were only 36 plants outside of the monitoring plot at the Whiskey Gap site, a decrease of 64 plants from when Wallis (1988) surveyed the site in 1987. At the Hendry occurrence, little difference in size of the population outside of the monitoring plots between 1987 and 1998 was observed (Wallis 1988, Cornish 1998).

The proportion of flowering stems appears to have decreased in all populations although the decline is most evident at Hendry #4, Police Outpost and Whiskey Gap where no flowering stems were recorded in 1998. With the data available to date it is not possible to determine whether this change in the proportion of flowering stems is reflective of a long-term trend or simply due to chance. That is, 1998 may not have been a good year for flowering. It is evident that the number of stems of western blue flag has decreased since 1987 in all but one (Hendry #1) of the monitoring plots. However, again due to the limited number of data points, it is unclear whether this change in stem numbers is reflective of a long-term trend in population status or part of a short-term natural cycle. Given the perennial nature of the species and the fact that it can persist vegetatively for several years, the differences in numbers between these two years may in fact represent a long-term trend in population status observed in 1998.

2. Other Areas. - No accurate population estimates are available for western blue flag outside of Alberta. However, the species appears to be widespread and common within the core of its range in the United States and has been considered a pest species in some areas (e.g., Nevada; Eckert et al. 1973).

LIMITING FACTORS

Plants have a number of characteristics distinct from those of animals that must be factored into any program aimed at their conservation. Schemske et al. (1994) identified these characteristics as "seed dormancy, a diversity of mating systems from self-fertilization to complete outcrossing, and frequent reliance on animals for the dissemination of pollen and seeds". Growing plants are also sedentary with many complex and intimate relationships with their habitat, both below and above ground. Processes such as habitat alteration and fragmentation thus have direct consequences to plant populations.

Table 1. Change in numbers of Iris missouriensis stems at permanent monitoring plots in southwest Alberta in 1987 and 1998 (after Wallis 1988 and Corninsh 1998).

Occurence/Plot	Total		Change	% Change
	1987	1998		
Hendry #1	168	230	+62	+37
Hendry #2	428	248	-180	-42
Hendry #3	809	733	-76	-9
Hendry #4	283	163	-120	-42
Whiskey Gap	103	77	-26	-25
Police Outpost P. P.	267	0	-267	-100

Table 2. Ratios of flowering (f) stems to non-flowering (nf) stems of Iris missouriensis at monitoring plots in southwestern Alberta in 1987 and 1998 (after Wallis 1988 and Cornish 1998).

Occurence/Plot	Non-flowering stems		Flowering stems		Ratio (f:nf)	
	1987	1998	1987	1998	1987	1998
Hendry #1	157	225	11	5	1:14	1:45
Hendry #2	421	248	7	1	1:60	1:248
Hendry #3	694	661	115	72	1:6	1:9
Hendry #4	261	163	22	0	1:12	-
Police Outpost P. P.	249	0	18	0	1:14	-
Whiskey Gap	103	77	0	0	-	-

The endangerment of plant species is usually attributed to one of four things: overexploitation, habitat destruction, competition from non-native species or spread of disease (Wilson 1992). Threats to small populations fall into three categories: genetic (loss of genetic variation and hence ability to adapt), demographic (unpredictable changes in population sizes, composition, etc.) and environmental (Noss et al. 1997, Purdy 1998). Genetic and demographic threats increase with a decrease in the population size while environmental threats can be independent of population size (Noss et al. 1997).

Wallis (1988) identified modification of habitat, competition from introduced plants and heavy cattle grazing as threats to the Alberta populations of western blue flag. He suggested that the main limiting factor in the habitat of native Alberta populations was a combination of moisture regime and grazing intensity. Cornish (1998) also identified grazing intensity and exotic species as threats and, in addition, considered flooding to be a cause of decline in one population.

1. Habitat Loss, Alteration and Fragmentation. - Western blue flag has probably never been common in Alberta given that it is at the northern edge of its range and that it has specific habitat requirements (see 'Habitat' section, above). Its historical range is difficult to determine because information on its occurrence is not found in the literature prior to 1964. However, it is likely that

alteration of habitat within its distribution has resulted in the loss of some pre-settlement populations.

Fescue-dominated systems, grassland and parkland, where western blue flag occurs, "are among the most threatened biogeographic regions on the Canadian plains because of extensive cultivation" (Alberta Environmental Protection 1997a). It has been stated that 85 to 95% of the Parkland Natural Region has been lost through activities such as cultivation and urbanization and "any remaining areas should be considered endangered" (Alberta Environmental Protection 1997a). Some of the greatest losses of native prairie have been in the Foothills Fescue Grassland (Alberta Environmental Protection 1997b). Weins (1996) recently estimated that 95% of Fescue Grassland has been lost. Wallis (1989) estimated that less than 100 km^2 of the Foothills Grassland that might have harboured western blue flag in the past is in native condition. The extent of fragmentation and habitat loss can be seen in Figure 3 which shows areas, by quarter section, with 75 to 100% of native vegetation remaining. Wetlands in the grassland systems have also been under intense pressure from being drained and filled. Estimates of loss of grassland in Alberta are 63% in the White Zone (settled portion of the province; Strong et al. 1993).

Noss et al. (1997) argue that:

> "Habitat needs often must be considered in terms of the constellation of patches of potentially suitable, potentially connected habitat across a large landscape, rather than site by site. Single sites or a collection of disconnected sites will often be insufficient for long-term survival."

Effective management of a species therefore needs to include the conservation of potential habitat that is available for recolonization (Schemske et al. 1994).

2. Competition from Introduced Species. - Competition from non-native (introduced) species is an increasing threat to native flora and fauna (Wilcove et al. 1998). Indeed, smooth brome is outcompeting western blue flag at a rapid pace in at least one of the known native occurrences, Police Outpost Provincial Park (Cornish 1998). Wallis (1988) noted that the primary vegetation at the location of monitoring plots at that occurrence in 1987 was native grasses (inland bluegrass and tufted hairgrass) although non-native species such as Kentucky bluegrass and timothy were also noted. Eleven years later (1998), Cornish noted that the predominant vegetation cover at this same plot was Bromus inermis, smooth brome. She speculated that the flooding and subsequent deposition of sediment that had occurred between 1987 and 1997 had killed the native vegetation thus allowing smooth brome to invade from nearby cultivated fields (Cornish 1998). She noted that invasion by smooth brome was threatening the remainder of the western blue flag population outside of the plot.

Competition from non-native species was not reported for other occurrences in 1998 although there was an increase in the amount of timothy at the monitoring plot Hendry #1 (Wallis 1988, Wallis 1989, Wallis and Bradley 1990, Cornish 1998). However, competition from introduced species at sites other than Police Outpost Provincial Park remains a potential threat.

3. Grazing. - Eradication of western blue flag from native grasslands in Nevada was actively promoted in the 1970s (Eckert et al. 1973). This occurred because western blue flag is unpalatable to livestock (Pryor and Talbert 1958), may cause poisoning (Great Plains Flora

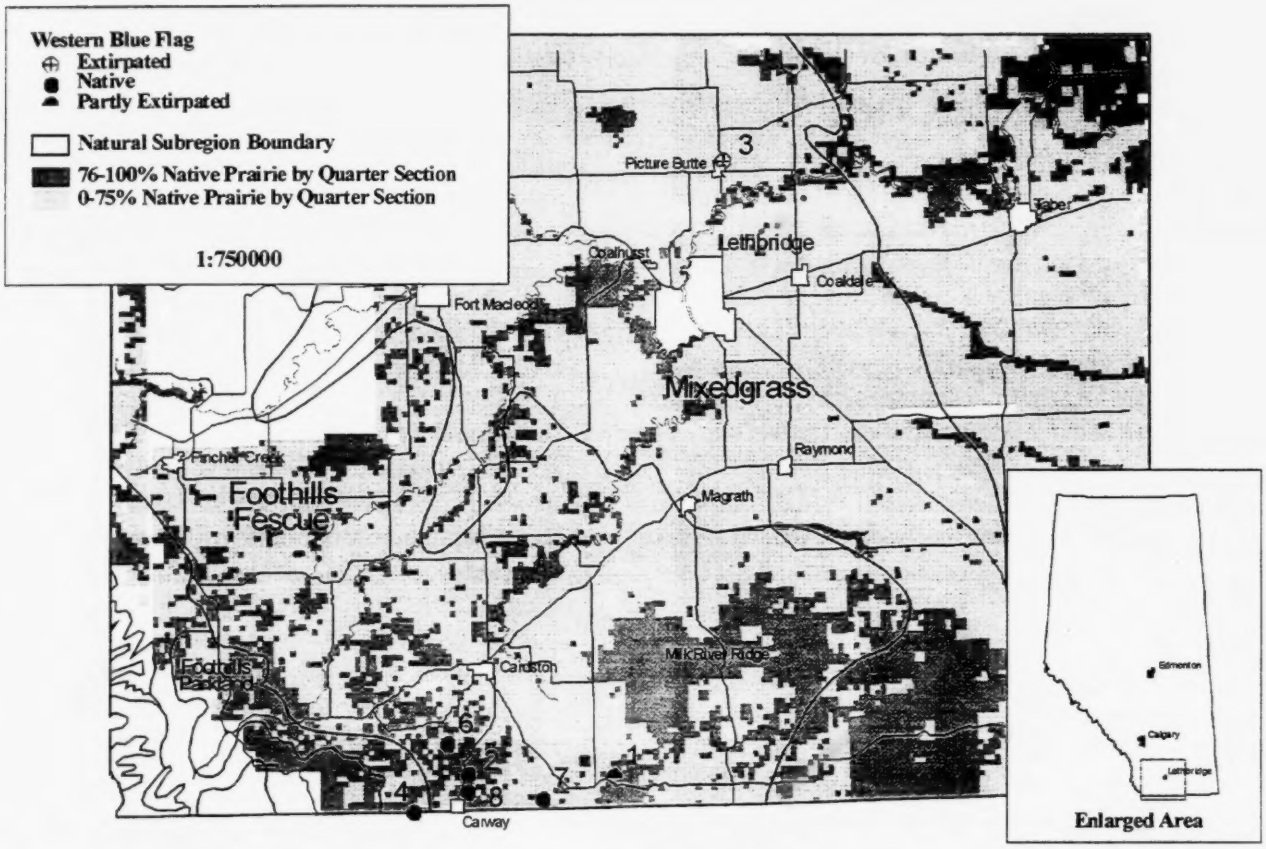

Figure 3. Known native occurences of western blue flag in Alberta (Alberta Natural Heritage Information Centre 1998b). Native prairie data compiled by Resource Data Division (RDD) of Alberta Environmental Protection for Agriculture, Food and Rural Development (1992).

Association 1986) and tends to increase in lightly to moderately grazed areas in parts of its range (Eckert et al. 1973). It is unknown whether native populations of western blue flag have been actively removed for similar reasons in Alberta.

Heavy grazing pressure appears to have a negative impact on western blue flag both in Alberta (Wallis 1989, Wallis and Bradley 1990, Cornish 1998) and North Dakota (D. Lenz, pers. comm.). Both Wallis (1988, 1989) and Cornish (1998) found that moderate to heavy grazing levels at the Whiskey Gap location have resulted in a reduction in the number and vigour of plants. However, levels of moderate to light grazing may be beneficial (Wallis 1989, Wallis and Bradley 1990, Cornish 1998) as noted at all sites except Police Outpost Provincial Park. The main effect of grazing on western blue flag may not be due to grazing of the plant itself but rather to alteration of drainage patterns and hydrology resulting from trampling. Wallis (1989) suggests that this alteration of hydrology as a result of cattle use may be the cause of the population decline at the Whiskey Gap location (see 'Alteration of Hydrology' section, below).

Conversely, lack of grazing may also be a limiting factor. The population at Police Outpost Provincial Park is not subject to use by cattle and plants appear to have reduced levels of flower production (Wallis 1989). It is uncertain whether this is attributable to lack of grazing or to other factors.

4. Alteration of Hydrology. - Changes in hydrology constitute a limiting factor at both the Whiskey Gap and Police Outpost locations. At the Whiskey Gap location, western blue flag occurs just below a seepage area. Cattle congregate in the vicinity of this seepage, causing trampling of the plants and diversion of water (Wallis 1989, Wallis and Bradley 1990).

The population of western blue flag at Police Outpost Provincial Park is near the shore of Outpost Lake. Water in the lake is replenished from springs and precipitation, as there is no inflow stream. The stream draining the lake has an outflow structure across it that was built to maintain water levels high enough to prevent winterkill of sport fish in Outpost Lake (D. Brown, pers. comm.). During periods of abundant precipitation, water levels in the lake are high enough to flood out a portion of the population of western blue flag (D. Brown, pers. comm.).

5. Horticultural and Medicinal Uses. - Western blue flag is also threatened by digging of rhizomes for horticultural and medicinal purposes. Western blue flag is an attractive plant and it is listed for sale in several gardening sources. Propagation can be done from either seed or rhizome although most gardening sources appear to be selling only seed. Western blue flag is included on the seed lists of some Alberta seed suppliers but it is difficult to track down the source of these seeds (i.e., whether collected from the wild or from nursery propagation; J. Lancaster, pers. comm.). The impact of the removal of seed on the long-term viability of populations is unknown.

Various medicinal uses of Iris (including western blue flag) have been reported. These include induction of vomiting, cleansing the system and treating Staphylococcus sores (Moore 1979, Kershaw et al. 1998). The rhizomes of western blue flag may also have anticancer properties (Wong et al. 1987). The full extent of collection of western blue flag in Alberta for horticultural or medicinal purposes is currently unknown.

6. Climate Change. - No data is available specifically on the impact of climate change on western blue flag. However, Morse et al. (1993) estimate that 7 to 11% of North America's vascular plant species would be negatively affected by a 3°C increase in temperature. Purdy (1998) indicates species such as western blue flag, which are at the northern edge of their range, may be better able to respond to global climate change due to their adaptation to local photoperiod, climate and soils. Therefore, what appears to be marginal habitat at present may become favourable habitat in the future (Purdy 1998).

7. Pests and Diseases. - No plant diseases or pests have been reported from any of the known populations of western blue flag in Alberta. However, Barry Greig (pers. comm.) of the University of Alberta, indicates that the species is susceptible to fungus and other diseases when grown in cultivation at the Devonian Botanic Garden.

8. Herbicides. - Herbicides are used in various parts of the United States to control western blue flag. The chemical that is most effective in suppressing growth of this species is 2,4-D (Eckert et al. 1973). Its use in areas in close proximity to western blue flag is 91 to 100%

effective in killing the plants (Eckert et al. 1973). Cornish (1998) notes that the poor vigour of western blue flag at Hendry #4 might be attributed to spraying of nearby willows.

9. Pollinators and Seed Dispersal Agents. - Pollination requires a minimum density of individuals and this may be a particularly important factor in small populations of western blue flag (Allee et al. 1949, Powell and Powell 1987). The role of pollinators and seed dispersers in determining the status of western blue flag is unknown in Alberta. No information is available on whether bees are the active pollinating agents in Iris or if some other agent (e.g., other invertebrates, wind) is involved. Given that western blue flag is restricted to isolated patches in southern Alberta, and that flowering density may be quite small, the role of pollinators may be small but important. It may be that self-pollination is important in some of these populations. Detailed demographic and genetic studies of Alberta western blue flag populations are required to ascertain this.

STATUS DESIGNATIONS

1. Alberta. - Western blue flag has long been recognized as a rare plant in Alberta (Argus and White 1978, Packer and Bradley 1984, Alberta Natural Heritage Information Centre 1996, AHNIC 1998a, Gould 1999). Argus and White (1978) define a rare species as one that "has a small population within the province or territory [and] may be restricted to a small geographical area or it may occur sparsely over a wide area". Packer and Bradley (1984) used the same definition but refined it to include only species that were known from five or fewer locations. Wallis et al. (1987) suggested the designation of 'endangered' for western blue flag. In a summary of the information on the rare vascular plants of Alberta, Wallis (1987) suggested five categories for priority of conservation. Category I has the highest priority. Iris missouriensis was classified as a Category II species meaning "one that is rare in much of, or a significant part of, its North American range, or is generally rare or uncommon in North America" (Wallis et al. 1987).

Plants are covered by the Alberta Wildlife Act however no status designations for plants have yet been assigned under this Act. The Alberta Natural Heritage Information Centre (ANHIC) was established in 1994 and the first tracking list for vascular plants ranked western blue flag as S1S2 (between 5-6 occurrences; Alberta Natural Heritage Information Centre 1996). This designation was based on the current botanical knowledge for this species in the province. Collation of specimen information and subsequent mapping of occurrences suggested the more appropriate rank of S1 (five or fewer occurrences and few remaining individuals). As of December 1998, the rank of western blue flag remains S1 given the few occurrences (six native and one extirpated) and apparent decline in number of plants and flowering density (Gould 1999).

2. Other Areas. - The Nature Conservancy global rank for western blue flag is G5, meaning it is known from more than 100 occurrences and is demonstrably secure within its range (Alberta Natural Heritage Information Centre 1998b). The western blue flag has been listed as 'threatened' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) since 1990 (COSEWIC 1998). This designation was based on the number of existing sites, the size of the populations and the loss of known sites. The species was also recognized as 'rare' in British Columbia in 1985 (Straley et al. 1985). However, the populations native to British Columbia have been re-examined and it has been determined that they are actually a different species, Iris

setosa (G. Douglas, pers. comm.).

Western blue flag is listed in *Rare Vascular Plants in Canada* (Argus and Pryer 1990). The national rank these authors assigned is N2 with a Canadian priority of 1 (Argus and Pryer 1990). A rank of N2 means that an element has 6 to 20 occurrences in Canada. However, this national rank is out of date and should be re-assessed since the B.C. populations were taken into account when assigning the rank. Canadian priority was determined to help rank species for conservation using criteria such as range within Canada, population size, threats and Nature Conservancy element ranks. A ranking of 1 indicates the highest priority for conservation.

Western blue flag has been assigned a Nature Conservancy sub-national rank of S1 in Nebraska and S2 in North Dakota (D. Lenz, pers. comm.). It is not considered to be rare in any of the other states in which it occurs, and in many states is considered abundant.

RECENT MANAGEMENT IN ALBERTA

A management plan for western blue flag has been prepared (Wallis 1989). However, no government agency had responsibility for protection and management of plants at the time the plan was prepared and few of the suggestions and recommendations have been implemented. Cornish (1998) reiterated many of the same recommendations made by Wallis (1989). The following discussion summarizes the strategies outlined in these two reports and subsequent management activities relating to them.

1. Monitoring. - Wallis (1989) recommended that tri-annual monitoring and annual inspections of the known populations be done. Cornish (1998) did the only detailed monitoring study subsequent to Wallis' initial work. The population at Police Outpost Provincial Park is visited weekly by park staff during the growing season to assess status and to monitor informal trail development in the vicinity (D. Brown, pers. comm.).

2. Research. - The staff at Police Outpost Provincial Park are exploring ways of controlling smooth brome as suggested by Cornish (1998; D. Brown, pers. comm.).

3. Communication. - Wallis (1989) listed several actions and strategies that could be undertaken to educate the public and provide information with respect to management and conservation of rare plants. These include production of educational media, contact with landowners and recognition of their contributions to conservation, involvement of conservation groups in promoting rare plant conservation using western blue flag as a demonstration species in the development of land use guidelines to protect significant habitats, storage of information on distribution and habitat in a database, and distribution of technical information to libraries. Many of these recommendations have been acted upon. Information on western blue flag was included in the *Alberta's Threatened Wildlife* brochure series (Alberta Forestry, Lands and Wildlife 1991) and rare-plant factsheets (Alberta Forestry, Lands and Wildlife, no date) produced by the Alberta government. Western blue flag is the emblem of the Alberta Native Plant Council, a not-for-profit group whose objectives are to "promote knowledge of Alberta's native plants, conserve Alberta's native plant species and their habitats and preserve this diverse resource for the enjoyment of present and future generations". Storage of information on distribution and habitat of the species is done at ANHIC and technical reports produced for Alberta Environmental Protection are housed in the library there. Communication

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APPENDIX 1. Definitions of selected legal and protective designations.

A. Status of Alberta Wildlife colour lists (after Alberta Wildlife Management Division 1996)

Red	Current knowledge suggests that these species are at risk. These species have declined, or are in immediate danger of declining, to nonviable population size
Blue	Current knowledge suggests that these species may be at risk. These species have undergone non-cyclical declines in population or habitat, or reductions in provincial distribution
Yellow	Species that are not currently at risk, but may require special management to address concerns related to naturally low populations, limited provincial distributions, or demographic/life history features that make them vulnerable to human-related changes in the environment
Green	Species not considered to be at risk. Populations are stable and key habitats are generally secure
Undetermined	Species not known to be at risk, but insufficient information is available to determine status

B. Alberta Wildlife Act

Species designated as 'endangered' under the Alberta Wildlife Act include those defined as 'endangered' or 'threatened' by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 1998)

Extirpated	A species no longer existing in the wild in Canada, but occurring elsewhere
Endangered	A species facing imminent extirpation or extinction
Threatened	A species likely to become endangered if limiting factors are not reversed
Vulnerable	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events
Not at Risk	A species that has been evaluated and found not to be at risk
Indeterminate	A species for which there is insufficient scientific information to support status designation

D. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range

E. Natural Heritage Element Rarity Ranks (after The Nature Conservancy 1998)

Global or G-rank: Based on the range-wide status of a species.
Sub-national or S-rank: Based on the status of a species in an individual state or province. S-ranks may differ between states or provinces based on the relative abundance of a species in each state or province.

G1 / S1	Critically imperiled because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction
G2 / S2	Imperiled because of rarity (6 to 20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range
G3 / S3	Either very rare or local throughout its range, or found locally in a restricted range (21 to 100 occurrences)
G4 / S4	Apparently secure, though it might be quite rare in parts of its range, especially at the periphery
G5 / S5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery

APPENDIX 2. Details of western blue flag occurences in Alberta (after Alberta Natural Heritage Information Centre 1998b)[a].

Occurence Number and Name [b]	Number of Stems in 1989[c]	Observation Date	Comments
1 Whiskey Gap*	200, one population extirpated	1-Jul-64	Two subpopulations, one has been eliminated (B. de Vries, pers. comm.)
		4-Aug-87	203 non-flowering stems (Wallis 1988)
		20-Jun-98	111 non-flowering stems and 2 flowering (Cornish 1998)
2 Hendry; near Carway*	5000	30-Jun-64	
3 Picture Butte*	0 (extirpated)	19-Jun-79	Extirpated
4 Police Outpost Provincial Park*	650	8-Jul-80	C. Wallis observed about 600 to 650 stems (Wallis 1988)
		17-Jun-86	20 flowering stalks (Wallis 1989)
		19-Jun-87	18 flowering stalk (Wallis 1989)
		1-Jul-89	6 flowering stalks (Wallis 1989)
		22-Jun-98	About 325 individuals, only 1 flowering stalk; no Iris in monitoring plot (Cornish 1998)
5 Whiskey Gap South		2-Jun-92	Introduced
6 'Beazer'*	1500	25-Jun-89	Several hundred flowering stalks with perhaps 1500 stems (Wallis 1989)
7 Mary Lake*	small	1989	Wallis 1989
8 Carway*	small	1989	25-30 flowering stalks (Wallis 1989)
9 Calgary- University Heights		17-Jun-93	One plant in bloom; from the article looks like only one plant is there; introduced (Stiles 1995)
		1994	No bloom
		1995	No bloom
10 Calgary Airport		1997	400 plants – introduced (C. Wallis, pers. comm.)
11 Banff		Jun-96	1000 plants in 30 clumps and scattered individuals; 25% of population in bloom (C. Wallis, pers. comm.)
12 Frank Lake		1995	Introduced (C. Wallis, pers. comm.)

[a] Note that the results of the data search by the Alberta Natural Heritage Information Centre are not intended as a final statement on presence, absence, or condition of elements within a given area, or as a substitute for on-site surveys which may be required for environmental assessments.

[b] Native populations are indicated with an asterisk (*). Numbers correspond to locations plotted on Figures 1 and 3.

[c] After Wallis 1989; population estimates are for native occurences only.

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